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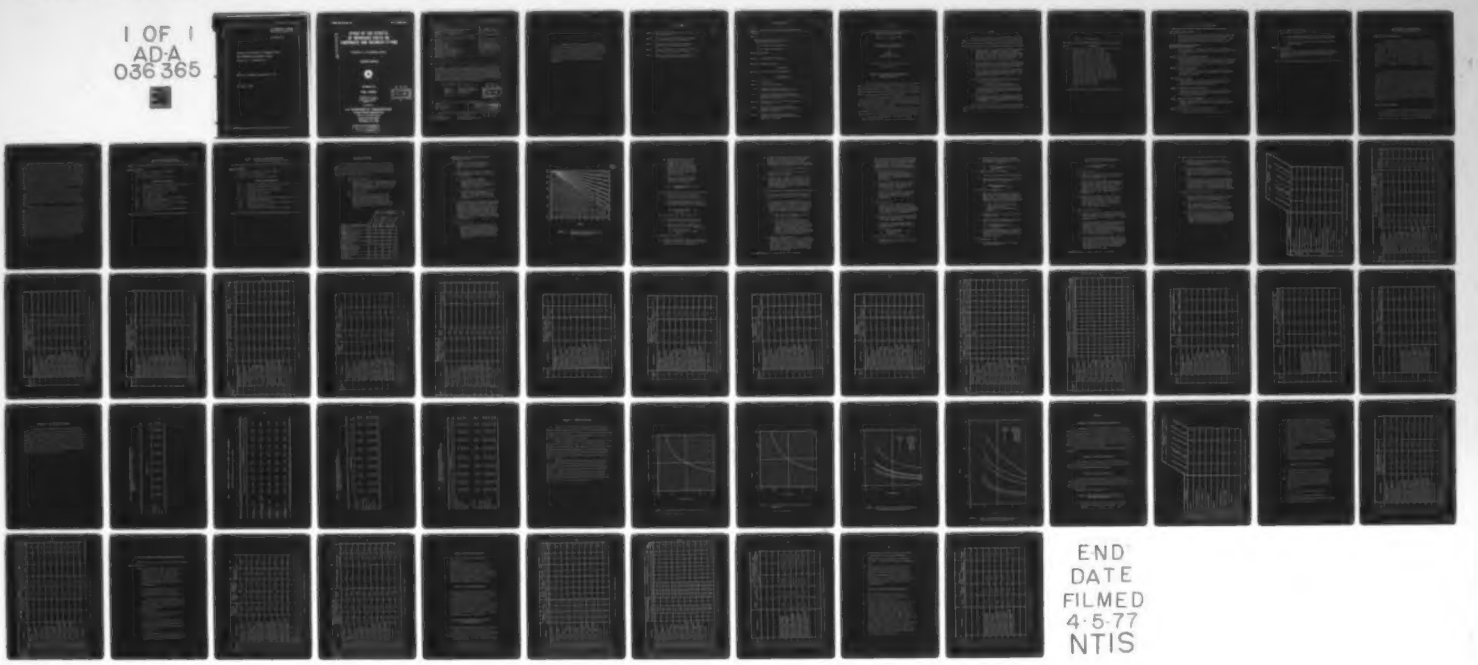

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STUDY OF THE EFFECTS OF INCREASED COSTS ON CORPORATE AND BUSINESS FLYING

VOLUME III. PLANNING GUIDE

BATTELLE COLUMBUS LABORATORIES, OHIO

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STUDY OF THE EFFECTS OF INCREASED COSTS ON CORPORATE AND BUSINESS FLYING

VOLUME III. PLANNING GUIDE

Battelle-Columbus

NOVEMBER 1975

FINAL REPORT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Office of Aviation Policy
Aviation Forecast Branch
Washington, D.C. 20591

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16. Abstract

This report, in four volumes, presents the results of research intended to enhance the utility of the original General Aviation Cost Impact Study (DOT-FA74WA-3118) by (1) identifying subcategories of business/corporate operators with varying effective after-tax sensitivities, (2) redefining the empirical cost impact relationships for business/corporate flying by using an expanded data base, and (3) providing information to permit greater insight into the nature of the business fleet by examining the financial characteristics of corporate owners.

The volumes included in this report are:

Volume I - Executive Summary
Volume II - Research Methodology
Volume III - Planning Guide
Volume IV - Data Base

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LIST OF FIGURES

TABLE OF CONTENTS

LIST OF TABLES

FINAL REPORT

on

STUDY OF THE EFFECTS OF INCREASED COSTS ON
CORPORATE AND BUSINESS FLYING

VOLUME III: PLANNING GUIDE

to

FEDERAL AVIATION ADMINISTRATION
OFFICE OF AVIATION POLICY

from

BATTELLE
Columbus Laboratories

by

R. F. Porter, M. A. Duffy, and R. W. Cote

August 12, 1975

CHAPTER 1: DISCUSSION OF LIMITATIONS AND INSTRUCTIONS FOR USE

This volume presents the analytical results of this study in a format which permits quick estimates of cost impact to be made. Cost sensitivity coefficients are presented for each aircraft type within the business/corporate user category; however, cost impact relationships are given for turbine-powered, fixed-wing aircraft only.

As an aid to "setting up the problem" and using the charts properly, a general procedure is presented in this chapter as a guideline for the general cost impact evaluation process. A number of worksheets and supplementary data are included to facilitate the analysis.

Once the user of this document gains familiarity with the use of the cost sensitivity and cost impact relationships, his approach can be more flexible and, in many cases, some steps in the generalized procedure may be skipped. The generalized procedure is intended to provide a guideline for consistent evaluation of cost impacts resulting from regulatory changes.

Scope

The scope of cost sensitivity and cost impact evaluations permitted by the data presented in this volume is determined by the scope of the analysis and capabilities of the methodology and data base discussed in Volume II. Briefly summarized this scope includes:

(1) Typical costs of owning and operating various business aircraft types. Therefore, the level of detail involved does not permit analysis by aircraft make and model; rather, the average characteristics of all aircraft, new and used, of a given type (e.g., twin engine piston) are the basis for analysis.

(2) FAA definitions of aircraft types are used since they provide the link into historical data and past work. Definitions of aircraft types are given in Table 1.

(3) Cost sensitivity analysis is based on the specification of major cost centers, which include all the important costs of ownership and operation. These are defined in Table 2.

(4) Cost impacts on activity are measured in terms of two basic activity measures:

- number of aircraft (ownership)
- annual hours flown (volume of flying).

Other activity measures can be derived from these by using appropriate performance characteristics, traffic statistics, etc.

(5) The information provided in this volume is intended to provide useful inputs to FAA forecasters and policymakers. Policy recommendations are not part of the scope of this study.

When background information, in addition to data presented in this volume, is needed, the analyst should refer to other volumes in this report.

TABLE 1. AIRCRAFT TYPES

Type No.	Definition
1	Single-engine piston, 1 to 3 place
2	Single-engine piston, 4 place and over
3	Twin-engine piston, under 12,500 lb TOGW
4	Twin-engine piston, over 12,500 lb TOGW
5	Multi-engine piston, over 12,500 lb TOGW
6	Twin-engine turboprop, under 20,000 lb TOGW
7	Twin-engine turboprop, over 20,000 lb TOGW
8	Twin-engine turbojet/fan, under 20,000 lb TOGW
9	Twin-engine turbojet/fan, over 20,000 lb TOGW
10	Multi-engine turbojet/fan, under 20,000 lb TOGW
11	Multi-engine turbojet/fan, over 20,000 lb TOGW
12	Rotary-wing, piston engine
13	Rotary-wing, turbine engine
14	Other

TABLE 2. COST CENTER DEFINITIONS

Fuel and Oil Costs ($/hour)

Fuel and oil cost per hour are based on the average consumption rate at 75 percent power. Airframe and engine manufacturers recommended fuel type were used for all calculations. The Fuel and Oil Cost Center includes state and federal fuel tax.

Airframe and Avionics Maintenance and Overhaul Cost ($/hour)

This cost center includes all labor and parts costs associated with scheduled and unscheduled airframe and avionics maintenance and overhaul.

Engine Maintenance and Overhaul ($/hour)

Engine maintenance and overhaul includes costs for scheduled and unscheduled engine maintenance, overhaul, 100 hour, 1000 hour, and/or annual inspections. Includes also midpoint and cycle costs for turbine engines.

Annualized Investment ($/year)

As developed in this study, the annualized investment is the average after-tax yearly cost of ownership of the aircraft, including crew costs.

Hull Insurance ($/year)

Hull insurance cost is the annual premium paid to insure the aircraft against damage while in motion or at rest. A deductible amount is normally included.

Liability and Medical Insurance ($/year)

Liability insurance premiums are paid to insure the aircraft owner against damage to persons or property by reason if his operation of the aircraft.

Hangar, Storage and Tie Down ($/year)

Hangar, storage and tie down rates are averaged from known regional hangar rates, parking fees, and manufacturer suggested rates.

Federal Registration Fee and Weight Tax ($/year)

The Federal registration fee and weight tax went into effect

TABLE 2. (Continued)

July 1, 1970. The rates are:

- Reciprocating powered aircraft - $25 plus $0.02 per pound for aircraft of gross weight over 2,500 plunds.
- Turbine powered aircraft - $25 plus $0.035 per pound of gross weight.

Miscellaneous ($/year)

Miscellaneous costs include allowance for the state aircraft registration fees, training, catering, landing fees, navigation materials, airworthiness directive requirements and minor modifications.

Interpretation of Cost Sensitivity and Cost Impact Relationships

Cost Sensitivity Relationships

A proposed change in regulations may affect the business/corporate user category by impacting one or more cost centers. Such a change in a cost center can be converted to a corresponding change in fixed, variable, or total cost. When the change in a cost center is expressed as a percentage change, the cost sensitivity relationships presented in this volume can be used to determine the corresponding percentage change in fixed, variable, or total cost. In cases where a proposed change affects more than one cost center, the resultant change in fixed, variable, or total cost is the algebraic sum of the changes occurring in each cost center.

The magnitude of cost center changes is used to determine percentage changes in cost centers which in turn are used to determine percentage changes in fixed, variable, or total cost. Percentage changes in fixed, variable, or total cost can then be converted to the corresponding dollar changes by multiplying the percentage change by the appropriate base cost. In the data presented in this volume, the base costs shown for each aircraft type are based on the 1972 cost structure for each segment, expressed in constant 1970 dollars. Therefore, for years other than 1970 the appropriate conversions and adjustments for inflation are required between the current year (year being analyzed) and the base year (1970).

Cost Impact Relationships

In this report, cost impact is expressed in terms of changes in two fundamental activity measures: (1) the number of hours flown (volume of flying) and (2) the number of aircraft (ownership). Other measures of activity can be derived from these two fundamental measures

by using appropriate performance characteristics, traffic statistics, etc. The cost impact concept implies that for a change in ownership or operating cost a corresponding change in activity would result purely from cost effects, assuming that the effects of other noncost variables remained constant. Regression analysis, as discussed in Volume II of this report, was used to determine the influence of important cost and noncost factors in explaining behavior within the business/corporate user category. The cost impact relationships presented in this volume show only the cost effects on activity by holding the level of noncost variables constant at the appropriate 1970 levels.

In Chapter 2, Volume II, results of the regression analysis indicate that only the turbine-powered aircraft activity can be explained, with any confidence, using the regression model of the previous Cost Impact Study. Therefore, the cost impact analysis guide presented in this Volume is applicable to the turbine powered aircraft types only.

The cost impact relationships were determined using 1970 as a base year. Proposed regulatory changes obviously can occur in years other than 1970; but, the relationship between cost and noncost variables can be assumed to be relatively stable over the near future. Therefore, the percentage changes in activity indicated on the appropriate cost impact relationship curves can be applied directly to projections of activity. However, if in the judgment of the analyst substantial changes in the relative levels of noncost variables are likely to occur in the year being analyzed, then calculations of activity changes should be made directly from the regression equations. The regression equations have been summarized in Table 3 for this purpose.

TABLE 3. SUMMARY OF REGRESSION EQUATIONS
POOLED TURBINE POWERED AIRCRAFT MODEL

Number of Aircraft

$$\ln N = -3.59 + 0.732 \ln H + 0.751 \ln \frac{PRD}{FC}$$
$$+ 1.20 \ln (N-1) + 0.551 \ln PRF$$
$$\ln H = -1.158 + 2.478 \ln ECH - 0.535 \ln VC$$

Definition of Variables

ln	-	denotes the variable is converted to its natural logarithm
ECH	=	the value of executive time per hour
FC	=	the annual fixed cost of the aircraft
H	=	the number of hours flown
N	=	the number of aircraft
(N-1)	=	the number of aircraft in the year immediately preceding the year under consideration
PRD	=	aircraft productivity, expressed as seat miles per hour
PFR	=	corporate profits before tax
VC	=	the variable cost per hour of aircraft operation

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VC	=	the variable cost per hour of aircraft operation

EVALUATION PROCEDURE

The starting point for evaluation of cost effects due to a proposed regulatory change is a careful review of all available documentation describing the change. Then the procedure outlined below can be followed to evaluate cost sensitivity and cost impact on the business/corporate user category.

A. Aircraft Types Affected

(1) Identify from Table 1, the aircraft types affected by the proposed change. Cost sensitivity can be evaluated for types 1, 2, 3, 6, 7, 8, 9, 11, 12, and 13. Cost impact can be evaluated only for turbine-powered aircraft.

B. Cost Centers Affected

(1) Check the cost centers affected by the proposed change in Worksheet A-1. These are the cost centers to be analyzed in this evaluation. The cost centers most likely to be affected by various attributes of a proposed change are checked below, as a guide.

	COST CENTERS	ATTRIBUTES: REQUIRED EQUIPMENT	SAFETY PROCEDURES (INCL. MAINT. & INSP.)	PILOT PROFICIENCY	ECONOMIC CONSTRAINTS
VARIABLE	FUEL AND OIL		X	X	
VARIABLE	AIRFRAME AND AVIONICS M&O	X	X	X	
VARIABLE	ENGINE MAINT. & OVERHAUL	X	X	X	
FIXED	ANNUALIZED INVESTMENT	X			X
FIXED	HULL INSURANCE	X	X	X	
FIXED	MEDICAL & LIABILITY INS.		X	X	
FIXED	HANGAR, STORAGE & TIEDOWN				
FIXED	FED. REG. & WEIGHT TAX				X
FIXED	MISCELLANEOUS			X	

C. Quantitative Effect of Proposed Change on Variable Cost Centers

(1) Variable costs are associated with operation of a given aircraft type and are expressed in dollars per hour.

(2) Are the effects of inflation included in the estimates of variable cost changes in the analysis?

__a. Yes. Enter cost changes in current dollars column on Worksheets B (e.g., a cost change effective in 1975 is expressed in terms of 1975 dollars).

__b. No. Enter cost changes in constant dollars column on Worksheets B (e.g., a cost change effective in 1975 is expressed in terms of 1970 dollars).

(3) If cost changes are in terms of current dollars (2.a above), convert to constant 1970 dollars and enter on Worksheets. Refer to data presented in Figure 1 for conversion factors between current dollars and constant 1970 dollars at various average inflation rates. In order to use results of variable cost-sensitivity analysis as inputs to cost impact analysis, all costs must be expressed in terms of 1970 dollars.

(4) Fuel and Oil (F)

a. For all aircraft types affected by the proposed change, indicate the amount of fuel and oil cost change, in dollars per gallon, on Worksheet B-1. Enter costs in constant (1970) or current dollar columns on Worksheet B-1 as determined in C(2) above.

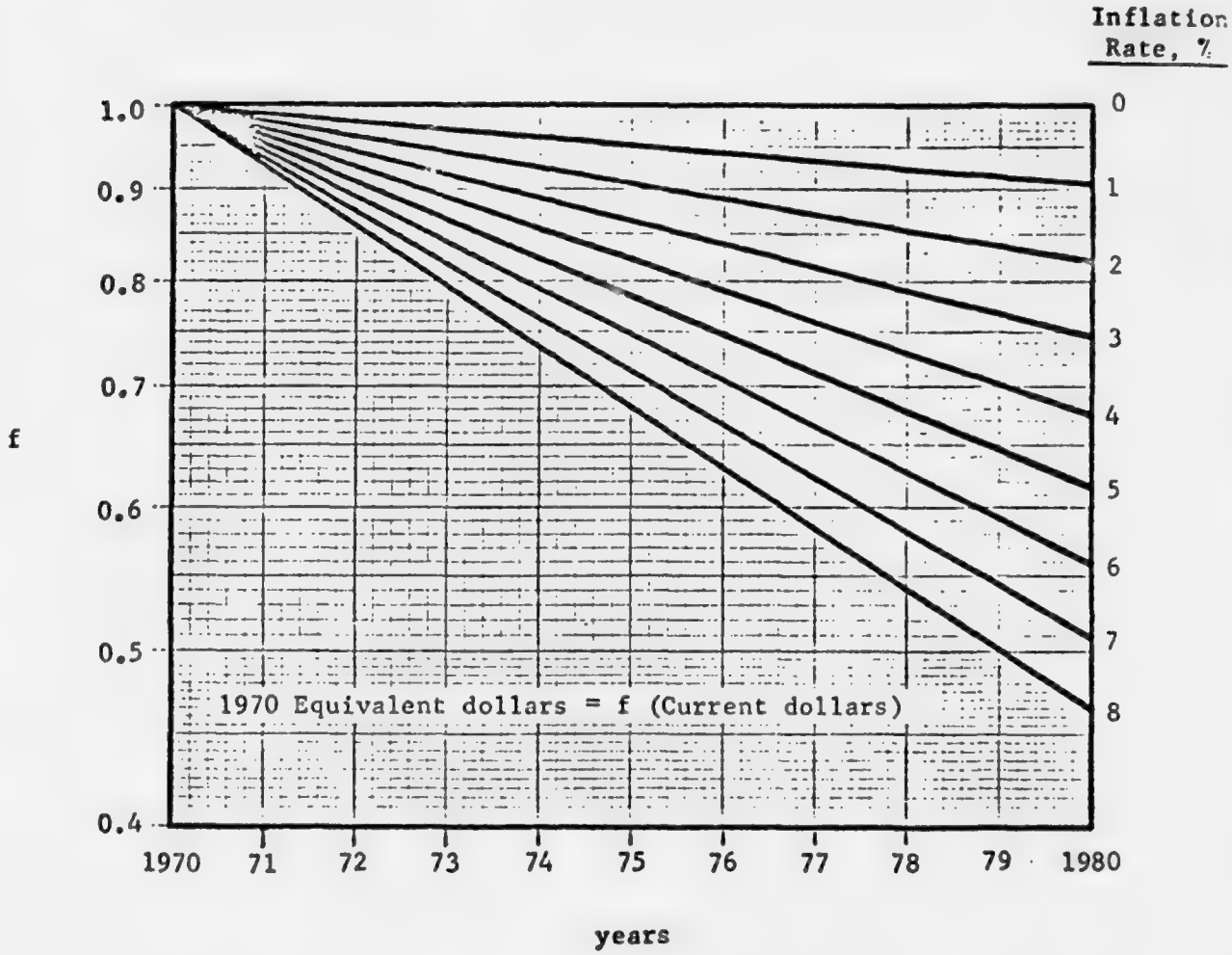

FIGURE 1. CONVERSION OF CURRENT DOLLARS TO 1970 EQUIVALENT DOLLARS

b. Average fuel consumption rates (gallons per hour) for each aircraft type are shown in Worksheet B-1. Multiply fuel and oil center change (dollars per gallon) by fuel consumption rates (gallons per hour) to get fuel and oil cost center change (dollars per hour).

c. Calculate percentage change in fuel and oil cost center (%ΔF), and enter on Worksheet B-1:

$$\%\Delta F = \frac{\text{Cost Center Change}}{\text{Base Cost}} \times 100\%$$

(5) Airframe and Avionics Maintenance and Overhaul (A)

a. Estimate net increment per hour of operation and enter on Worksheet B-2.

b. Calculate percentage change in Airframe and Avionics Maintenance and Overhaul Cost Center (%ΔA) and enter on Worksheet B-2:

$$\%\Delta A = \frac{\text{Cost Center Change}}{\text{Base Cost}} \times 100\% \ .$$

(6) Engine Maintenance and Overhaul (E)

a. Estimate net increment per hour of operation and enter on Worksheet B-3.

b. Calculate percentage change in cost center (%ΔE) and enter on Worksheet B-3:

$$\%\Delta E = \frac{\text{Cost Center Change}}{\text{Base Cost}} \times 100\% \ .$$

D. Variable Cost Sensitivity

(1) Summarize quantitative effects on variable cost centers as determined in Worksheets B-1, B-2, and B-3 by entering on Worksheet C-1.

(2) Using the appropriate Variable Cost Sensitivity Coefficient (Table 4)* for each percentage change in cost center value (e.g., %ΔF) calculate the corresponding percentage change in variable cost (%ΔVC) and enter on Worksheet C-1.

$$\%\Delta VC = \%\Delta F \times \text{sensitivity coefficient}$$

Cost Sensitivity Coefficients are given in Chapter 2 of this Volume.

(3) Add percentage changes in variable cost due to changes in each variable cost center to get total percentage change in variable cost for each aircraft type. Enter in Worksheet C-1. (These values will be used to enter the Cost Impact Relationships).

E. Quantitative Effect of Proposed Change on Fixed Cost Centers

(1) Fixed costs are associated with ownership of an aircraft and are expressed in dollars per year.

(2) Are the effects of inflation included in the estimates of fixed cost changes in this sensitivity analysis? In order to use results of fixed cost sensitivity analysis as inputs to cost impact analysis, all costs must be expressed in terms of constant 1970 dollars.

__a. Yes. Enter cost changes in current dollar column on Worksheets.

__b. No. Enter cost changes in constant 1970 dollar column on Worksheet D-1. If cost changes are in terms of current dollars, convert to constant 1970 dollars and enter on Worksheets. Refer to Figure 1 for conversion factors between current dollars and constant 1970 dollars at various average inflation rates.

(3) Annualized Investment (AI)
Influence coefficients indicate the dependence of annual ownership costs on the values of sales tax, investment tax credit, mortgage interest rate, salaries, and aircraft purchase price. Table 5* gives the influence coefficients for the composite business/corporate user category for each aircraft type.

* Included in Chapter 2, pages 35 and 36, respectively.

The influence coefficient for aircraft purchase price is used to convert before-tax equipment or modification costs to equivalent annual after-tax costs. For consistency, it is recommended that all annualized investment changes be computed in constant 1970 dollars.

a. List average investment cost of equipment (or modification) required by the proposed regulatory change in Worksheet D-1. Convert these costs to 1970 dollars.

b. Divide investment cost by the average aircraft purchase price factors shown in Worksheet D-1. This yields the percentage change in costs.

c. Multiply by the influence coefficients shown in Worksheet D-1 to obtain the percentage increment in annualized investment.

(4) Hull Insurance (H)

a. A change in hull insurance premium is associated with a change in hull value (i.e., equipment or modification required). Enter change in hull value (Equipment Cost from Worksheet D-1) on Worksheet D-2.

b. Multiply change in hull value by premium rate shown in Worksheet D-2 and enter in cost center change column.

c. Calculate percentage change in Hull Insurance cost center (%ΔH) and enter on Worksheet D-2

$$\%\Delta H = \frac{\text{Cost Center Change}}{\text{Base Cost}} \times 100\% \ .$$

(5) Medical and Liability Insurance (L)

a. Determine cost center change and enter on Worksheet D-3.

b. Calculate percentage change in Medical and Liability Insurance (%ΔL) Cost Center and enter on Worksheet D-3:

$$\%\Delta L = \frac{\text{Cost Center Change}}{\text{Base Cost}} \times 100\% .$$

(6) Hangar, Storage, and Tiedown (S)

a. Enter cost center changes on Worksheed D-4.

b. Calculate percentage change in cost center (%ΔS) and enter on Worksheet D-4:

$$\%\Delta S = \frac{\text{Cost Center Change}}{\text{Base Cost}} \times 100\% .$$

(7) Federal User Charges (T)

a. This cost center includes the Federal registration fee and weight tax effective July 1, 1970. The base costs shown in Worksheet D-5 are based on $25 registration fee plus weight tax at the rates of

1. $.02 per lb. for piston aircraft over 2,500 lb. TOGW.
2. $.035 per lb. for turbine-powered aircraft.

b. Determine change in cost center and enter on Worksheet D-5.

c. Calculate percentage change in cost center (%ΔT) and enter on Worksheet D-5

$$\%\Delta T = \frac{\text{Cost Center Change}}{\text{Base Cost}} \times 100\% .$$

d. If proposed change includes differential changes for various segments, fill out one Worksheet D-5 for each group of user categories involved.

(8) Miscellaneous (M)

a. Determine changes in cost center and enter on Worksheet D-6

b. Calculate percentage change in cost center (%ΔM) and enter on Worksheet D-6:

$$\%\Delta M = \frac{\text{Cost Center Change}}{\text{Base Cost}} \times 100\% \ .$$

F. Fixed Cost Sensitivity

(1) Summarize quantitative effects on fixed cost centers, as determined in (E), by entering on a separate Worksheet E-1.

(2) Using the appropriate Fixed Cost-Sensitivity Relationships (Table 6)* for each percentage change in cost center value (e.g., %ΔAI) calculate the corresponding percentage change in Fixed Cost (%ΔFC) and enter on Worksheet E-1. %ΔFC = %ΔAI x Sensitivity Coefficient.

(3) Add percentage changes in fixed cost due to changes in each fixed cost center to get total percentage change in fixed cost for each aircraft type. Enter on Worksheet F-1. (These values will be used to enter cost impact relationships.)

G. Total Cost Sensitivity

(1) Summarize quantitative effects on Variable and Fixed Cost Centers, as determined in (C) and (E), by entering percentage changes on a separate Worksheet F-1.

(2) Using the appropriate Total Cost Sensitivity Relationships (Table 7)*, for each percentage change in cost center value (E.B., %ΔF) calculate the corresponding percentage change in Total Cost (%ΔTC), and enter on Worksheet F-1. Summarize, on Worksheet F-1, by adding total %ΔTC for each aircraft type.

(3) If desired, the magnitude (in 1970 dollars) of cost changes associated with total %ΔTC value for each aircraft type can be determined using Worksheet F-2, by multiplying the base cost by the appropriate %ΔTC value. [The magnitude of cost changes in each cost center has been determined in (C) and (E)].

* Included in Chapter 2, pages 37 and 38, respectively.

H. Cost Impact Estimate--Turbine Aircraft Utilization

(1) Summarize Variable Cost Sensitivity values--total %ΔVC for each aircraft type--(from Worksheet C-1) on Worksheet G-1.

(2) Using the appropriate Cost-Impact Relationships (Figure 2), for each value of total %ΔVC, read the corresponding value for percentage change in fleet utilization and enter on Worksheet G-1.

(3) Enter base year values of utilization on Worksheet G-1 and calculate magnitude of utilization changes by multiplying by appropriate percentage change in fleet utilization. If desired, base year values can be adjusted for the calculated change in hours flown and entered on Worksheet G-1 as net utilization.

I. Cost-Impact Estimate--Fleet Size

(1) Summarize Fixed Cost Sensitivity Values--total %ΔFC for each aircraft type--(from Worksheet E-1) on Worksheet H-1, using a separate worksheet.

(2) Using the appropriate Cost-Impact Relationships from Figure 3, for each value of total %ΔFC, read the corresponding value for percentage change in fleet size and enter on Worksheet H-1.

(3) Enter base year values of fleet size on Worksheet H-1, and calculate magnitude of fleet size changes by multiplying by appropriate fleet size percentage changes. If desired, base year values can be adjusted for the calculated change in fleet size and entered as net fleet size on Worksheet H-1.

	COST CENTERS	ATTRIBUTES: REQUIRED EQUIPMENT	SAFETY PROCEDURES (INCL. MAINT. & INSP.)	PILOT PROFICIENCY	ECONOMIC CONSTRAINTS
VARIABLE	FUEL AND OIL				
	AIRFRAME AND AVIONICS M&O				
	ENGINE MAINT. & OVERHAUL				
FIXED	ANNUALIZED INVESTMENT				
	HULL INSURANCE				
	MEDICAL & LIABILITY INS.				
	HANGAR, STORAGE & TIEDOWN				
	FED. REG. & WEIGHT TAX				
	MISCELLANEOUS				

WORKSHEET A-1 COST CENTERS AFFECTED BY PROPOSED CHANGE

AIRCRAFT TYPE	DESCRIPTION	FUEL RATE GAL./HR	COST CHANGE, $/GAL		COST CENTER CHANGE, $/HR		BASE COST $/HR	% Δ F
			CURRENT ___ YEAR	CONSTANT 1970	CURRENT ___ YEAR	CONSTANT 1970		
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE	10.3					4.58	
2	SINGLE-ENGINE PISTON 4 PLACE & OVER	13.5					6.82	
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW	33.6					16.84	
6	TWIN-ENGINE TURBOPROP UNDER 20,000 lb TOGW	63.1					32.11	
7	TWIN-ENGINE TURBOPROP OVER 20,000 lb TOGW	231.0					103.55	
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW	292.0					130.60	
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	381.0					170.56	
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	605.0					271.03	
12	ROTARY WING-PISTON	14.0					6.24	
13	ROTARY WING-TURBINE	25.7					11.51	

WORKSHEET B-1. FUEL AND OIL COST CENTER CHANGES

AIRCRAFT TYPE	DESCRIPTION	COST CENTER CHANGE		BASE COST	% Δ A
		$/HR CURRENT ____YEAR	CONSTANT 1970	$/HR	
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE			1.68	
2	SINGLE-ENGINE PISTON 4 PLACE & OVER			2.78	
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW			8.79	
6	TWIN-ENGINE TURBOPROP UNDER 20,000 lb TOGW			19.37	
7	TWIN-ENGINE TURBOPROP OVER 20,000 lb TOGW			84.67	
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW			47.24	
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			111.31	
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			112.63	
12	ROTARY WING-PISTON			9.71	
13	ROTARY WING-TURBINE			14.71	

WORKSHEET B-2. AIRFRAME AND AVIONICS MAINTENANCE & OVERHAUL CHANGES

AIRCRAFT TYPE	DESCRIPTION	COST CENTER CHANGE $/HR		BASE COST $/HR	% Δ E
		CURRENT ____YEAR	CONSTANT 1970		
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE			1.26	
2	SINGLE-ENGINE PISTON 4 PLACE & OVER			1.95	
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW			8.60	
6	TWIN-ENGINE TURBOPROP UNDER 20,000 lb TOGW			19.98	
7	TWIN-ENGINE TURBOPROP OVER 20,000 lb TOGW			15.04	
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW			39.14	
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			59.49	
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			86.11	
12	ROTARY WING-PISTON			3.40	
13	ROTARY WING-TURBINE			16.17	

WORKSHEET B-3. ENGINE MAINTENANCE & OVERHAUL CHANGES

AIRCRAFT TYPE	DESCRIPTION	FUEL AND OIL (F)		AIRFRAME & AVIONICS (A)		ENGINE (E)		TOTAL
		% Δ F	% Δ V_C	% Δ A	% Δ V_C	% Δ E	% Δ V_C	% Δ V_C
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE							
2	SINGLE-ENGINE PISTON 4 PLACE & OVER							
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW							
6	TWIN-ENGINE TURBOPROP UNDER 20,000 lb TOGW							
7	TWIN-ENGINE TURBOPROP OVER 20,000 lb TOGW							
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW							
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW							
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW							
12	ROTARY WING-PISTON							
13	ROTARY WING-TURBINE							

WORKSHEET C-1. VARIABLE COST (VC) SENSITIVITY

AIRCRAFT TYPE	DESCRIPTION	EQUIPMENT COST 1970 DOLLARS	PURCHASE PRICE FACTOR	PERCENT CHANGE IN PRICE	INFLUENCE COEFFICIENT	%ΔAI
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE		185		0.70	
2	SINGLE-ENGINE PISTON 4 PLACE & OVER		264		0.75	
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW		1,089		0.62	
6	TWIN-ENGINE TURBOPROP UNDER 20,000 lb TOGW		4,763		0.59	
7	TWIN-ENGINE TURBOPROP OVER 20,000 lb TOGW		13,890		0.78	
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW		8,697		0.70	
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW		20,256		0.83	
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW		20,835		0.80	
12	ROTARY WING-PISTON		470		0.38	
13	ROTARY WING-TURBINE		1,100		0.35	

WORKSHEET D-1. ANNUALIZED INVESTMENT CHANGES

AIRCRAFT TYPE	DESCRIPTION	CHANGE IN HULL VALUE, $		PREMIUM RATE	COST CENTER CHANGE, $	BASE COST $/YR	% Δ H
		CURRENT ____YEAR	CONSTANT 1970				
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE			0.043		427	
2	SINGLE-ENGINE PISTON 4 PLACE & OVER			0.038		534	
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW			0.020		1151	
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW			0.015		4331	
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW			0.013		10410	
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW			0.011		5762	
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			0.010		11134	
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			0.010		10410	
12	ROTARY WING-PISTON			0.120		2820	
13	ROTARY WING-TURBINE			0.100		5544	

WORKSHEET D-2 HULL INSURANCE CHANGES

AIRCRAFT TYPE	DESCRIPTION	CHANGE IN COST CENTER, $		BASE COST $/YR	% Δ L
		CURRENT ____YEAR	CONSTANT 1970		
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE			83	
2	SINGLE-ENGINE PISTON 4 PLACE & OVER			143	
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW			167	
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW			694	
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW			1665	
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW			638	
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			694	
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			1823	
12	ROTARY WING-PISTON			162	
13	ROTARY WING-TURBINE			306	

WORKSHEET D-3 MEDICAL AND LIABILITY INSURANCE CHANGES:

AIRCRAFT TYPE	DESCRIPTION	COST CENTER CHANGE, $		BASE COST $/YR	% Δ S
		CURRENT ____YEAR	CONSTANT 1970		
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE			263	
2	SINGLE-ENGINE PISTON 4 PLACE & OVER			299	
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW			648	
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW			1310	
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW			5702	
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW			4213	
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			4655	
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			5476	
12	ROTARY WING-PISTON			289	
13	ROTARY WING-TURBINE			382	

WORKSHEET D-4. HANGAR, STORAGE AND TIEDOWN COST CHANGES

AIRCRAFT TYPE	DESCRIPTION	CHANGE IN COST CENTER, $		BASE COST $/YR	% Δ T
		CURRENT ____YEAR	CONSTANT 1970		
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE			12	
2	SINGLE-ENGINE PISTON 4 PLACE & OVER			36	
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW			69	
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW			189	
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW			655	
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW			284	
9	TWIN-ENGINE TURBOJET/FAN OVER 20,0001b TOGW			615	
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			653	
12	ROTARY WING-PISTON			14	
13	ROTARY WING-TURBINE			64	

WORKSHEET D-5 FEDERAL USER CHARGE (T) CHANGES

AIRCRAFT TYPE	DESCRIPTION	COST CENTER CHANGES, $		BASE COST $/YR	% Δ M
		CURRENT ____ YEAR	CONSTANT 1970		
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE			44	
2	SINGLE-ENGINE PISTON 4 PLACE & OVER			58	
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW			97	
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW			1096	
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW			2961	
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW			2023	
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			4248	
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			4294	
12	ROTARY WING-PISTON			56	
13	ROTARY WING-TURBINE			94	

WORKSHEET D-6. MISCELLANEOUS (M) COST CHANGES

AIRCRAFT TYPE	DESCRIPTION	ANNUALIZED INVESTMENT		HULL INSURANCE		MEDICAL & LIABILITY INSURANCE		HANGER STORAGE & TIEDOWN		FEDERAL USER CHARGES		MISCELLANEOUS		TOTAL
		%Δ AI	%Δ FC	%Δ H	%Δ FC	%Δ L	%Δ FC	%Δ S	%Δ FC	%Δ T	%Δ FC	%Δ M	%Δ FC	%Δ FC
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE													
2	SINGLE-ENGINE PISTON 4 PLACE & OVER													
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW													
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW													
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW													
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW													
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW													
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW													
12	ROTARY WING-PISTON													
13	ROTARY WING-TURBINE													

WORKSHEET E-1. FIXED COST (FC) SENSITIVITY

AIRCRAFT TYPE	DESCRIPTION	VARIABLE COST CENTERS						FIXED COST CENTERS												TOTAL
		% Δ						% Δ												
		F	TC	A	TC	E	TC	AI	TC	H	TC	L	TC	S	TC	T	TC	M	TC	% Δ TC
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE																			
2	SINGLE-ENGINE PISTON 4 PLACE & OVER																			
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW																			
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW																			
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW																			
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW																			
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW																			
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW																			
12	ROTARY WING-PISTON																			
13	ROTARY WING-TURBINE																			

WORKSHEET F-1. TOTAL COST (TC) SENSITIVITY

AIRCRAFT TYPE	DESCRIPTION	TOTAL % Δ TC	TOTAL COST, $		TOTAL COST CHANGE, $	
			HOURLY	ANNUAL	HOURLY	ANNUAL
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE					
2	SINGLE-ENGINE PISTON 4 PLACE & OVER					
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW					
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW					
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW					
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW					
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW					
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW					
12	ROTARY WING-PISTON					
13	ROTARY WING-TURBINE					

WORKSHEET F-2. MAGNITUDE OF TOTAL COST (TC) CHANGES

AIRCRAFT TYPE	DESCRIPTION	TOTAL % Δ VC	% Δ HOURS FLOWN	BASE UTILIZATION, HRS (_____YEAR)	CHANGE IN UTILIZATION (HOURS)	NET UTILIZATION (HOURS)
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW					
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW					
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW					
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW					
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW					

WORKSHEET G-1. COST IMPACT ESTIMATE - TURBINE AIRCRAFT UTILIZATION

AIRCRAFT TYPE	DESCRIPTION	TOTAL % Δ FC	% Δ NUMBER OF AIRCRAFT	BASE FLEET SIZE (AIRCRAFT)	CHANGE IN FLEET SIZE	NET FLEET SIZE
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW					
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW					
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW					
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW					
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW					

WORKSHEET H-1. COST IMPACT ESTIMATE - FLEET SIZE

CHAPTER 2: COST-SENSITIVITY CHARTS

This portion of Volume III presents the Cost-Sensitivity Coefficients for each aircraft type within the business/corporate user category. The charts can be used in conjunction with the Cost-Impact Relationships shown in Chapter 3 of this volume; or they can be used independently to determine fixed, variable, and total cost sensitivity to changes in fixed or variable cost centers. To conduct a general cost impact evaluation of a proposed regulatory change, the limitations andinstructions in Chapter 1 of this volume should serve as guidelines for the use of the figures in this chapter.

TABLE 4. VARIABLE COST SENSITIVITY COEFFICIENTS COMPOSITE BUSINESS/CORPORATE USER CATEGORY - AFTER TAX - 1972 DATA

	AIRCRAFT TYPE									
Variable Cost	1	2	3	6	7	8	9	11	12	13
Fuel & Oil	.610	.590	.492	.449	.509	.602	.500	.577	.323	.272
A/F & Av.	.224	.240	.257	.271	.417	.218	.326	.240	.502	.347
Engine	.166	.170	.251	.280	.074	.180	.174	.183	.176	.381

TABLE 5. INFLUENCE COEFFICIENTS ON THE ANNUAL COST OF OWNERSHIP

Composite Business/Corporate User Category

	Aircraft Type									
	1	2	3	6	7	8	9	11	12	13
$\frac{\Delta A.I.}{\Delta \text{ Sales Tax}}$, %/Pt.	0.45	0.48	0.40	0.24	0.32	0.28	0.34	0.33	0.28	0.17
$\frac{\Delta A.I.}{\Delta \text{ Inv. Tax Crdt.}}$, %/Pt.	-1.14	-1.36	-1.14	-1.44	-1.90	-1.70	-2.00	-1.96	-0.60	-0.70
$\frac{\Delta A.I.}{\Delta \text{ Int. Rate}}$, %/Pt.	0.68	0.76	0.62	1.24	1.68	1.50	1.78	1.72	0.38	0.38
$\frac{\Delta A.I.}{\Delta \text{ Salary}}$, %/%	0.31	0.24	0.38	0.41	0.22	0.30	0.17	0.20	0.62	0.65
$\frac{\Delta A.I.}{\Delta \text{ A/C Price}}$, %/%	0.70	0.75	0.62	0.59	0.78	0.70	0.83	0.80	0.38	0.35

TABLE 6. FIXED COST SENSITIVITY COEFFICIENTS
COMPOSITE BUSINESS/CORPORATE USER CATEGORY
AFTER TAX - 1972 DATA

	Aircraft Type									
	1	2	3	6	7	8	9	11	12	13
Fixed Costs										
A. I.	.780	.778	.899	.874	.844	.863	.882	.882	.799	.827
Hull Insurance	.113	.111	.056	.072	.076	.061	.061	.054	.169	.150
Medical & Liability Insurance	.022	.030	.008	.012	.012	.007	.004	.009	.010	.008
Hangar, etc.	.070	.062	.031	.022	.042	.045	.026	.028	.017	.010
Federal Fee	.003	.007	.003	.003	.005	.003	.003	.003	.001	.002
Misc.	.012	.001	.005	.018	.022	.022	.023	.022	.003	.003

TABLE 7. TOTAL COST SENSITIVITY COEFFICIENTS
COMPOSITE BUSINESS/CORPORATE USER CATEGORY
AFTER TAX - 1972 DATA

	Aircraft Type									
	1	2	3	6	7	8	9	11	12	13
Variable Cost										
Fuel & Oil	.061	.105	.098	.106	.182	.238	.186	.248	.043	.047
A/F & Av.	.022	.043	.050	.064	.149	.086	.121	.103	.066	.061
Engine	.017	.030	.050	.066	.026	.071	.065	.079	.023	.067
Total	.100	.178	.198	.236	.357	.395	.372	.429	.132	.175
Fixed Costs										
A.I.	.701	.640	.720	.667	.543	.522	.554	.504	.694	.682
Hull Ins.	.102	.091	.045	.055	.049	.037	.038	.031	.147	.127
Med & Lia. Insurance	.020	.024	.006	.009	.008	.004	.002	.005	.008	.007
Hangar, etc.	.063	.051	.025	.016	.027	.027	.016	.016	.015	.009
Federal Fee	.003	.006	.003	.002	.003	.002	.002	.002	.001	.001
Misc.	.011	.010	.004	.014	.014	.013	.015	.013	.003	.002
Total	.900	.822	.802	.764	.643	.605	.628	.571	.868	.825

CHAPTER 3: COST-IMPACT CHARTS

This portion of Volume III contains the Cost-Impact Relationships for turbine powered aircraft only. These charts are intended to be used in conjunction with the Cost-Sensitivity Relationships presented in Chapter 2, and the instructions and limitations for cost-impact evaluation discussed in Chapter 1 of this volume.

Figures are included for the two fundamental activity variables analyzed in this cost impact study: fleet utilization and fleet size. Two types of cost impact charts are presented for each activity measure: (1) figures showing percentage change in activity versus percentage change in cost (fixed or variable) and (2) figures showing calculated activity levels for base year 1970 versus percentage change in cost (fixed or variable).

The preferred method for utilizing the cost impact charts is in conjunction with the worksheets and procedure given in Chapter 1 of this Volume. Base costs (1970 base year) for converting percentage changes to corresponding dollar values are given in the worksheets in Chapter 1. However, since it may sometimes be more convenient to by-pass the worksheets in making quick estimates of cost impact, base year costs have been summarized on the cost impact charts which show calculated levels of activity for base year 1970.

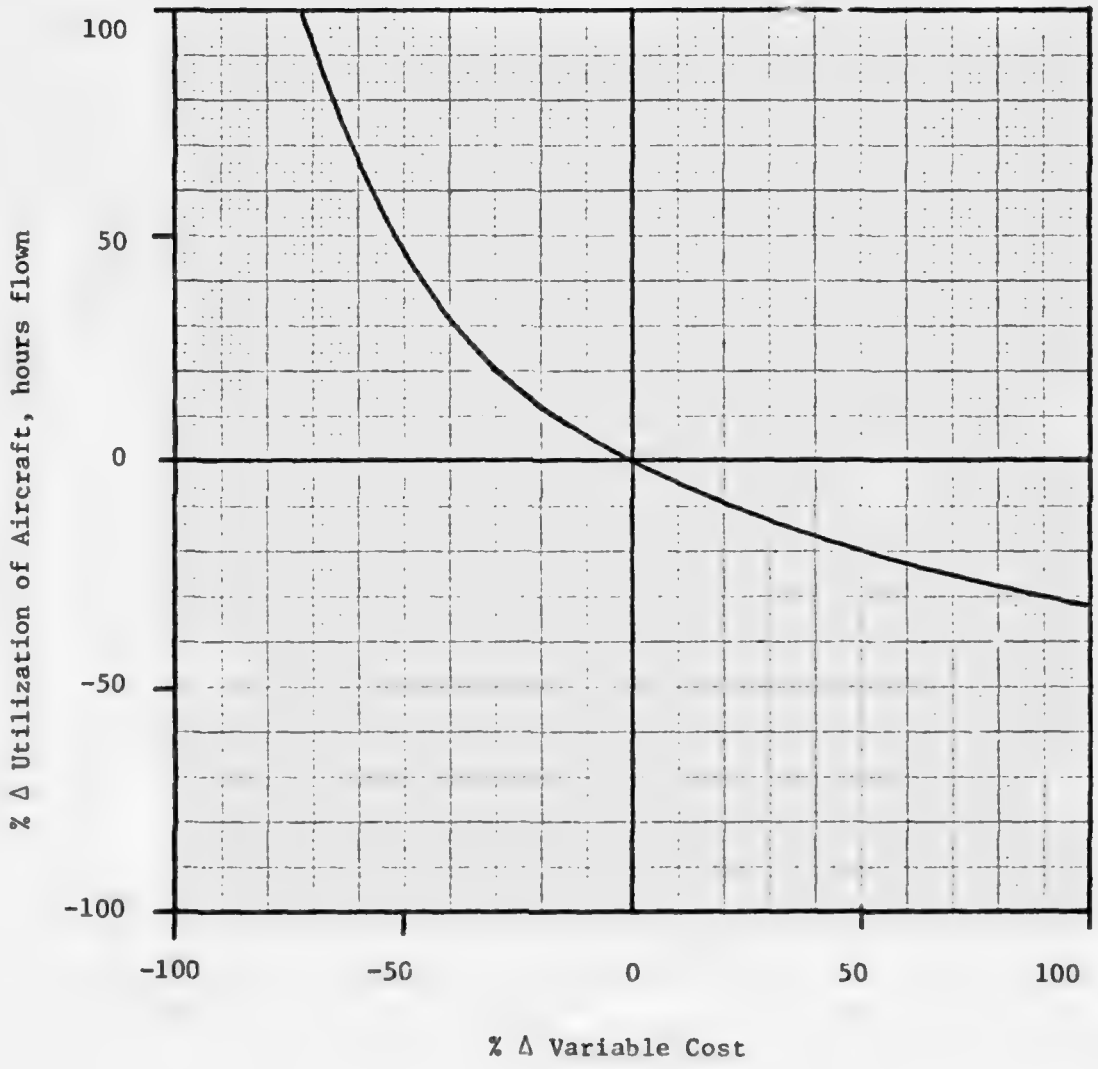

FIGURE 2. PERCENTAGE IMPACT OF VARIABLE COST CHANGES ON UTILIZATION (Pooled Turbine Model)

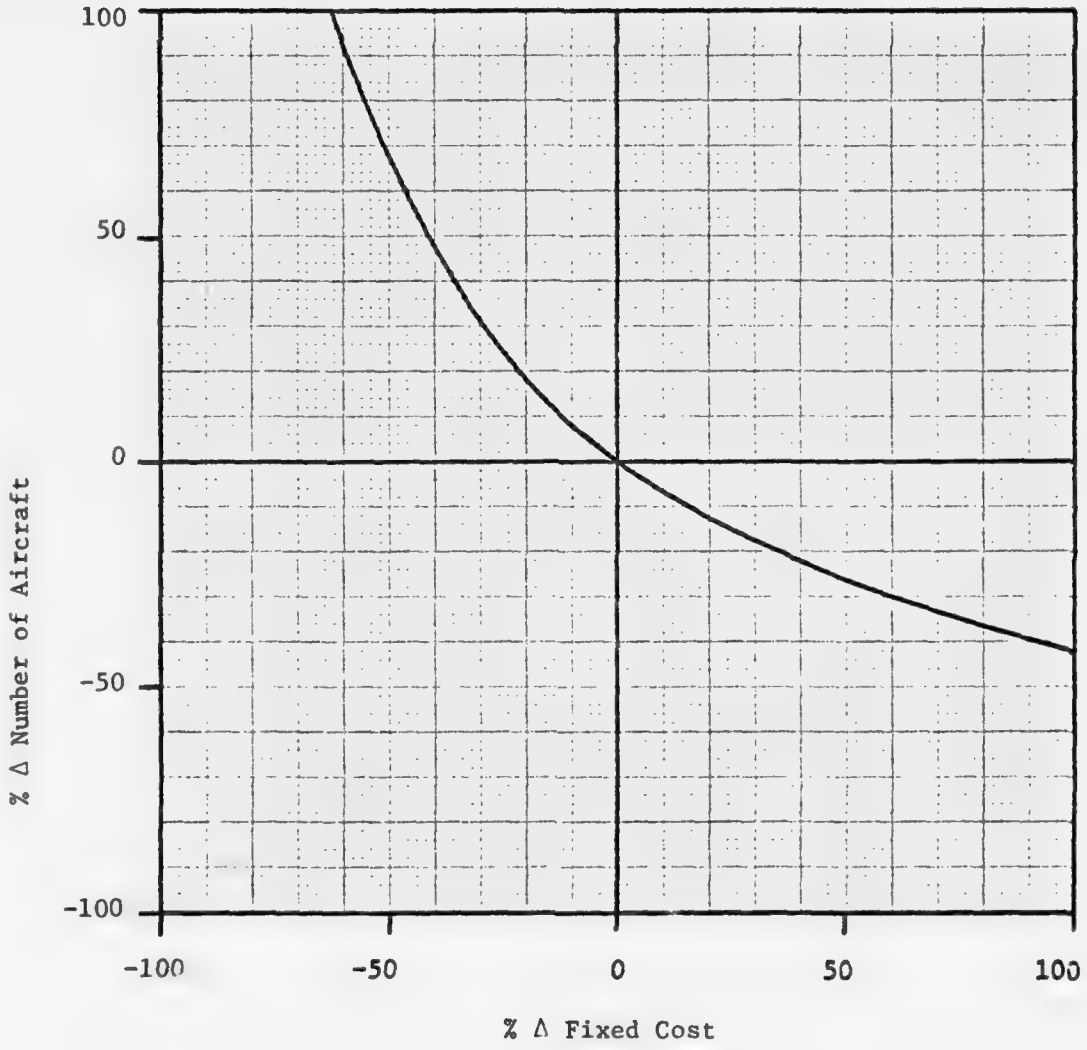

FIGURE 3. PERCENTAGE IMPACT OF FIXED COST CHANGES ON FLEET SIZE

(Pooled Turbine Model)

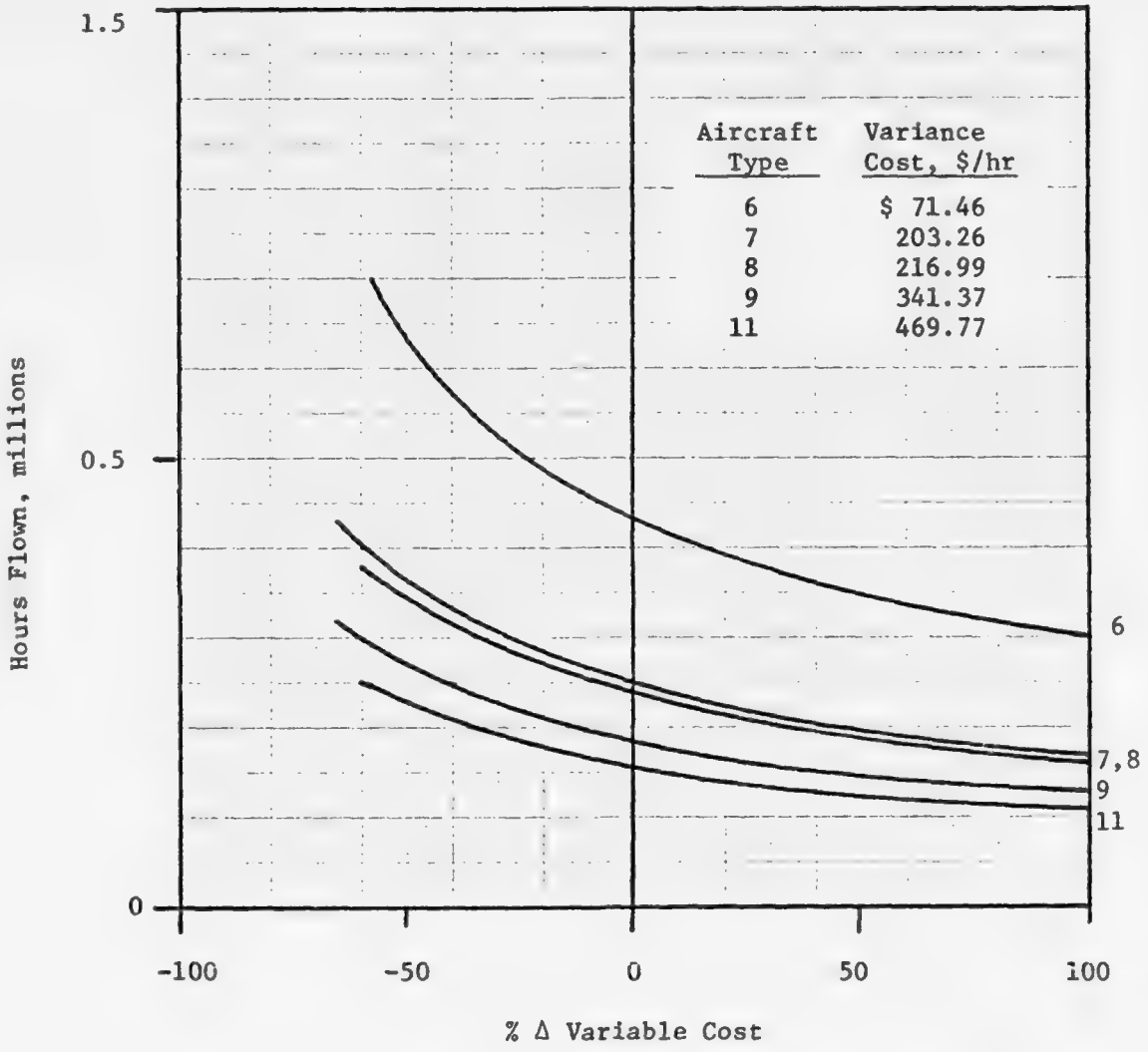

FIGURE 4. IMPACT OF VARIABLE COST CHANGES ON UTILIZATION OF INDIVIDUAL TURBINE AIRCRAFT TYPES

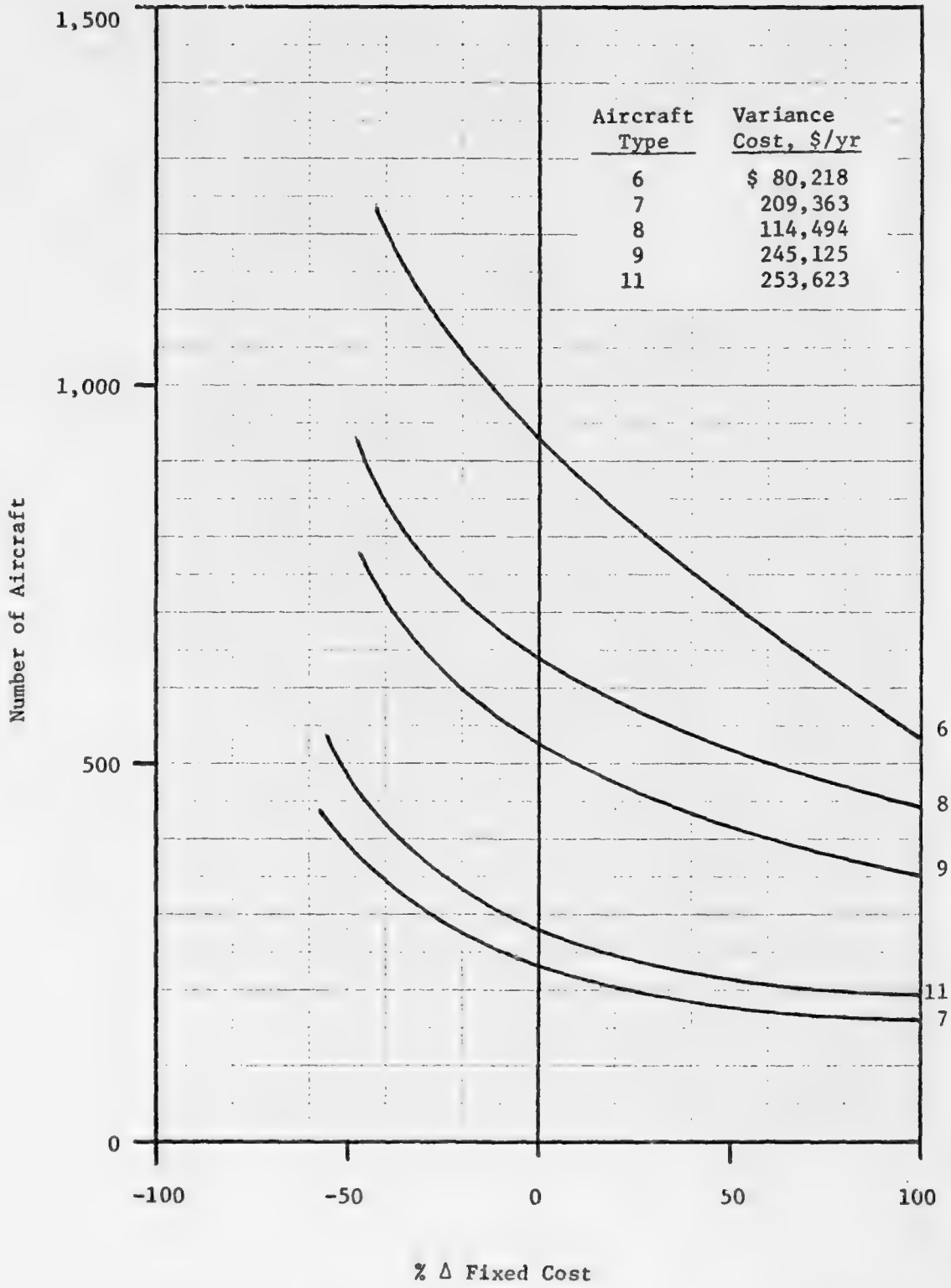

FIGURE 5. IMPACT OF FIXED COST CHANGES ON FLEET SIZE FOR INDIVIDUAL TURBINE AIRCRAFT TYPES

APPENDIX A

EXAMPLE OF COST IMPACT EVALUATION PROCEDURE

To illustrate the evaluation procedure outlined in Chapter 1, an example is used in which it is hypothesized that a new $4,000 "black box" is to become mandatory on all business/corporate aircraft. The nature of the device is unimportant for our purposes here, but is chosen to require increments in both fixed and variable costs. The variable cost increment results from an additional assumption that maintenance costs for the device will average 50 cents per hour of operation.

The steps in the procedure follow the outline beginning on page 9 of Chapter 1.

Step A: Aircraft Types Affected

In this example, all ten types under consideration are affected by the cost sensitivity portion, whereas the cost impact can be evaluated only for the turbine-powered fixed-wing aircraft.

Step B: Cost Centers Affected

As an item of "Required Equipment", the affected cost centers are the Airframe and Avionics Maintenace and Overhaul center under variable costs, and the Annualized Investment and Hull Insurance cost centers under the fixed cost items.

These are checked on Worksheet A-1.

Step C: Quantitative Effect of Proposed Change on Variable Cost Centers

(1) The only variable cost center affected is Airframe and Avionics Maintenance and Overhaul. The cost increment is 50 cents (1975 dollars) per hour.

COST CENTERS		ATTRIBUTES			
		REQUIRED EQUIPMENT	SAFETY PROCEDURES (INCL. MAINT. & INSP.)	PILOT PROFICIENCY	ECONOMIC CONSTRAINTS
VARIABLE	FUEL AND OIL				
	AIRFRAME AND AVIONICS M&O	X			
	ENGINE MAINT. & OVERHAUL				
FIXED	ANNUALIZED INVESTMENT	X			
	HULL INSURANCE	X			
	MEDICAL & LIABILITY INS.				
	HANGAR, STORAGE & TIEDOWN				
	FED. REG. & WEIGHT TAX				
	MISCELLANEOUS				

WORKSHEET A-1. COST CENTERS AFFECTED BY PROPOSED CHANGE

(2) Costs are given in 1975 dollars and, therefore must be converted to 1970 dollar equivalents. The avionics maintenance cost values are entered in the "current year" column of Worksheet B-2.

(3) Figure 1 of Chapter 1 indicates a conversion factor of 0.78, assuming an average inflation of 5 percent. Thus, in this example, 1975 dollars will be multiplied by 0.78 to convert to 1970 dollar equivalents. These values are shown in the "Constant 1970" column on Worksheet B-2.

(4) Omitted.

(5) The percentage change in the cost center is obtained by dividing the Cost Center Change by the Base Cost for each aircraft type and then multiplying by 100. These values are entered on Worksheet B-2.

Step D: Variable Cost Sensitivity

(1) The percentage change in the variable cost center is entered on Worksheet C-1. In this case, only the Airframe and Avionics center is affected.

(2) From Table 4 on page 35, the cost sensitivity coefficient is obtained for each aircraft type. Then, the percentage change in variable cost is computed from

$$\% \Delta VC = \% \Delta A \times \text{sensitivity coefficient.}$$

These values are entered on Worksheet C-1.

(3) The total percentage change is entered on the extreme right column of Worksheet C-1.

AIRCRAFT TYPE	DESCRIPTION	COST CENTER CHANGE		BASE COST	% Δ A
		$/HR CURRENT 1975 YEAR	CONSTANT 1970	$/HR	
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE	.50	.46	1.68	27.40
2	SINGLE-ENGINE PISTON 4 PLACE & OVER	.50	.46	2.78	16.50
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW	.50	.46	8.79	5.23
6	TWIN-ENGINE TURBOPROP UNDER 20,000 lb TOGW	.50	.46	19.37	2.37
7	TWIN-ENGINE TURBOPROP OVER 20,000 lb TOGW	.50	.46	84.67	0.54
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW	.50	.46	47.24	0.97
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	.50	.46	111.31	0.41
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	.50	.46	112.63	0.41
12	ROTARY WING-PISTON	.50	.46	9.71	4.71
13	ROTARY WING-TURBINE	.50	.46	14.71	3.13

WORKSHEET B-2. AIRFRAME AND AVIONICS MAINTENANCE & OVERHAUL CHANGES

AIRCRAFT TYPE	DESCRIPTION	FUEL AND OIL (F)		AIRFRAME & AVIONICS (A)		ENGINE (E)		TOTAL
		% Δ F	% Δ V_C	% Δ A	% Δ V_C	% Δ E	% Δ V_C	% Δ V_C
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE			27.40	6.14			6.14
2	SINGLE-ENGINE PISTON 4 PLACE & OVER			16.50	3.96			3.96
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW			5.23	1.34			1.34
6	TWIN-ENGINE TURBOPROP UNDER 20,000 lb TOGW			2.37	0.64			0.64
7	TWIN-ENGINE TURBOPROP OVER 20,000 lb TOGW			0.54	0.23			0.23
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW			0.97	0.21			0.21
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			0.41	0.13			0.13
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			0.41	0.10			0.10
12	ROTARY WING-PISTON			4.74	2.38			2.38
13	ROTARY WING-TURBINE			3.13	1.09			1.09

WORKSHEET C-1. VARIABLE COST (VC) SENSITIVITY

Step E: Quantitative Effect on Fixed Cost Centers

Two fixed cost centers are affected: Annualized Investment and Hull Instuance.

(3) a. Annualized Investment. The cost in 1975 dollars is $4,000. This is converted to 1970 dollars, as in the variable cost case, by applying a conversion factor of 0.78. This value is entered, for each aircraft type, under "Equipment Cost - 1970 Dollars" on Worksheet D-1.

b. The equipment cost is divided by the Purchase Price Factor to arrive at the Percentage Change in Price on Worksheet D-1.

c. The previous results are multipled by the respective influence coefficients on Worksheet D-1 to determine the percentage increment in Annualized Investment.

(4) Hull Insurance

a. The change in hull value is entered in 1970 dollars on Worksheet D-2.

b. Multiplying by the respective premium rate for each aircraft type determines the insurance cost change, which is also entered on the Worksheet.

c. The percentage change in Hull Insurance is obtained by dividing the previous result by the Base Costs tabulated on Worksheet D-2, and multiplying by 100.

AIRCRAFT TYPE	DESCRIPTION	EQUIPMENT COST 1970 DOLLARS	PURCHASE PRICE FACTOR	PERCENT CHANGE IN PRICE	INFLUENCE COEFFICIENT	%ΔAI
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE	3,120	185	16.86	0.70	11.80
2	SINGLE-ENGINE PISTON 4 PLACE & OVER	3,120	264	11.82	0.75	8.87
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW	3,120	1,089	2.87	0.62	1.78
6	TWIN-ENGINE TURBOPROP UNDER 20,000 lb TOGW	3,120	4,763	0.66	0.59	0.39
7	TWIN-ENGINE TURBOPROP OVER 20,000 lb TOGW	3,120	13,890	0.22	0.78	0.17
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW	3,120	8,697	0.36	0.70	0.25
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	3,120	20,256	0.15	0.83	0.12
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	3,120	20,835	0.15	0.80	0.12
12	ROTARY WING-PISTON	3,120	470	6.64	0.38	2.52
13	ROTARY WING-TURBINE	3,120	1,100	2.84	0.35	0.99

WORKSHEET D-1. ANNUALIZED INVESTMENT CHANGES

AIRCRAFT TYPE	DESCRIPTION	CHANGE IN HULL VALUE, $		PREMIUM RATE	COST CENTER CHANGE, $	BASE COST $/YR	% Δ H
		CURRENT 1975 YEAR	CONSTANT 1970				
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE	4,000	3,120	0.043	134	427	31.4
2	SINGLE-ENGINE PISTON 4 PLACE & OVER	4,000	3,120	0.038	119	534	22.3
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW	4,000	3,120	0.020	62	1151	5.4
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW	4,000	3,120	0.015	47	4331	1.1
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW	4,000	3,120	0.013	41	10410	0.39
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW	4,000	3,120	0.011	34	5762	0.59
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	4,000	3,120	0.010	31	11134	0.28
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	4,000	3,120	0.010	31	10410	0.30
12	ROTARY WING-PISTON	4,000	3,120	0.120	374	2820	13.3
13	ROTARY WING-TURBINE	4,000	3,120	0.100	312	5544	5.63

WORKSHEET D-2 HULL INSURANCE CHANGES

Step F: Fixed Cost Sensitivity

(1) The results of Step E are summarized on Worksheet E-1.

(2) Multiplying by the appropriate Fixed Cost Sensitivity relationship from Table 6 on page 37, the percentage increments in fixed costs are computed and entered on the Worksheet.

(3) The total percentage changes in fixed costs are obtained by adding the increments from Annualized Investment and Hull Insurance.

Step G: Total Cost Sensitivity

(1) The percentage increments in each cost center, from Worksheets B-2, D-1, and D-2, are entered in the appropriate columns of Worksheet F-1.

(2) Multiplying by the Total Cost Sensitivity coefficients of Table 7 on page 38, the increments in total cost are obtained, for each cost center, and entered in Worksheet F-1. The individual increments are then added to obtain the complete percentage increments in total cost.

Step H: Cost Impact Estimate - Turbine Aircraft Utilization

(1) The percentage increments in variable costs (from Worksheet C-1) are entered for each turbine-powered fixed-wing aircraft type on Worksheet G-1.

(2) If the increments were sufficiently large, the percentage change in aircraft utilization could be read directly from Figure 2 on page 40. In this case, because of the small cost increments, it is better to compute the impact directly from the regression equation on Table 3 on page 8. The

AIRCRAFT TYPE	DESCRIPTION	ANNUALIZED INVESTMENT		HULL INSURANCE		MEDICAL & LIABILITY INSURANCE		HANGER STORAGE & TIEDOWN		FEDERAL USER CHARGES		MISCELLANEOUS		TOTAL
		%Δ AI	%Δ FC	%Δ H	%Δ FC	%Δ L	%Δ FC	%Δ S	%Δ FC	%Δ T	%Δ FC	%Δ M	%Δ FC	%Δ FC
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE	11.8	9.2	31.4	3.55									12.75
2	SINGLE-ENGINE PISTON 4 PLACE & OVER	8.87	6.9	22.3	3.03									9.93
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW	1.78	1.6	5.4	0.30									1.90
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW	0.39	0.34	1.1	0.08									0.47
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW	0.17	0.14	0.39	0.03									0.17
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW	0.25	0.22	0.59	0.04									0.26
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	0.12	0.11	0.28	0.02									0.13
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	0.12	0.11	0.30	0.02									0.13
12	ROTARY WING-PISTON	2.52	2.01	13.3	2.25									4.26
13	ROTARY WING-TURBINE	0.99	0.82	5.63	0.84									1.66

WORKSHEET E-1. FIXED COST (FC) SENSITIVITY

AIRCRAFT TYPE	DESCRIPTION	VARIABLE COST CENTERS						FIXED COST CENTERS												TOTAL
		% Δ						% Δ												
		F	TC	A	TC	E	TC	AI	TC	H	TC	L	TC	S	TC	T	TC	M	TC	% Δ TC
1	SINGLE-ENGINE PISTON 1 TO 3 PLACE			27.4	0.60			11.8	8.27	31.4	3.20									12.07
2	SINGLE-ENGINE PISTON 4 PLACE & OVER			16.5	0.71			8.87	5.68	22.3	2.03									8.42
3	TWIN-ENGINE PISTON UNDER 12,500 lb TOGW			5.23	0.26			1.78	1.28	5.4	0.24									1.78
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW			2.37	0.15			0.39	0.26	1.1	0.06									0.47
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW			0.54	0.08			0.17	0.09	0.39	0.02									0.19
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW			0.97	0.08			0.25	0.13	0.59	0.02									0.23
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			0.41	0.05			0.12	0.07	0.28	0.01									0.13
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW			0.41	0.04			0.12	0.06	0.30	0.01									0.11
12	ROTARY WING-PISTON			4.74	0.31			2.52	1.75	13.3	1.96									4.02
13	ROTARY WING-TURBINE			3.13	0.19			0.99	0.68	5.63	0.70									1.57

WORKSHEET F-1. TOTAL COST (TC) SENSITIVITY

AIRCRAFT TYPE	DESCRIPTION	TOTAL % Δ VC	% Δ HOURS FLOWN	BASE UTILIZATION, HRS (_____YEAR)	CHANGE IN UTILIZATION (HOURS)	NET UTILIZATION (HOURS)
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW	0.64	-0.34	525,048	-1,785	523,263
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW	0.23	-0.12	159,963	-192	159,771
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW	0.21	-0.11	305,046	-336	304,710
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	0.13	-0.07	254,745	-178	254,567
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	0.10	-0.05	135,740	- 68	135,672

WORKSHEET G-1. COST IMPACT ESTIMATE - TURBINE AIRCRAFT UTILIZATION

desired percent utilization change is obtained by multiplying the percentage increment in variable cost by the appropriate coefficient (-0.535). These values are entered on Worksheet G-1.

(3) If desired, the base utilization rate for the year in question can be multiplied by the percentage utilization change just computed to obtain an absolute change in the prediction of hours flown. As an example, the 1972 utilization data from Volume IV has been used on the sample worksheet.

Step I: Cost Impact Estimate--Fleet Size

(1) The total increments in fixed costs, from Worksheet E-1, are entered on Worksheet H-1 for each turbine aircraft type.

(2) If these increments had been sufficiently large, Figure 3 on page 41 could have been used to estimate the percentage increment in fleet size. Instead, the appropriate coefficient from the regression equation of Table 3 (0.751) is used as a multiplier. (Note that $\ln \frac{PRD}{FC} = \ln PRD - \ln FC$, the appropriate multiplier then, is -0.751.)

(3) Again, using the 1972 fleet size as a reference, the absolute numbers of aircraft can be computed on Worksheet H-1. Note that, in this example, only types 6 and 8 are affected enough to permit round-off to whole aircraft numbers.

AIRCRAFT TYPE	DESCRIPTION	TOTAL % Δ FC	% Δ NUMBER OF AIRCRAFT	BASE FLEET SIZE (AIRCRAFT)	CHANGE IN FLEET SIZE	NET FLEET SIZE
6	TWIN-ENGINE TURBOPROP UNDER 12,500 lb TOGW	0.42	-0.32	1,002	3	999
7	TWIN-ENGINE TURBOPROP OVER 12,500 lb TOGW	0.17	-0.13	213	0	213
8	TWIN-ENGINE TURBOJET/FAN UNDER 20,000 lb TOGW	0.26	-0.20	538	1	537
9	TWIN-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	0.13	-0.10	405	0	405
11	MULTI-ENGINE TURBOJET/FAN OVER 20,000 lb TOGW	0.13	-0.10	220	0	220

WORKSHEET H-1. COST IMPACT ESTIMATE - FLEET SIZE